STATUS OF THE CLAIMS

Claims 1-10 are pending.

Claims 1-4 and 7-10 stand rejected.

Claims 5-6 stand objected to.

Claim 9 is amended herein.

Claims 5-6 have been cancelled.

New claims 11 and 12 have been added.

REMARKS

Reconsideration of this application is respectfully requested. Claims 5-6 have been cancelled, and Applicant has added new claims 11-12 to rewrite claims 5-6 in independent form, as suggested by Examiner. Also, claim 9 has been amended to further emphasize the claimed invention. No new matter has been added. Applicant believes that the following remarks address and overcome all of the Examiner's rejections and objections.

I. Inventorship

As the Examiner notes in the Office Action, this application currently names joint inventors. As the Examiner advises, Applicant asserts that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made.

II. Rejections Under 35 U.S.C. § 103

Claim 1-4 and 7-8 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Yuge et al. (5,182,091) in view of DE 29 24 584. This basis for rejection is traversed, because there is no proper basis or nexus for the Examiner's suggested combination of those references. Applicant submits that those references cannot be combined as suggested by Examiner. Even if the references could be combined, notwithstanding the lack of a proper nexus, they still would not make the invention recited in claims 1-4 and 7-8.

Claim 1 of the present invention, shown here in previously amended form, recites:

> 1. A silicon refining method comprising the steps of:
> filling a cold inductive crucible (1) with solid silicon;
> melting the content of the crucible;
> creating, by means of the inductive crucible, a turbulent stirring of the silicon melt (b) by bringing the liquid from the bottom of the crucible to the free surface by ascending along the central axis of the crucible; and
> directing a plasma (f) generated by an inductive plasma torch (2) towards the melt surface for a duration enabling elimination of impurities for which the reactive gas (g_r) of the plasma is adapted.

As Examiner asserts, Yuge '091 discloses a method of silicon purification, consisting of directing an arc plasma toward the surface of a silicon melt, contained in a hot crucible with silica or silica based refractory walls. The high speed of the plasma sets the melt in motion, and the intensity of the resulting motion depends on the plasma power. Examiner states that "it would have been obvious to one or ordinary skill in the art at the time the invention was made to use an inductive plasma instead of an arc plasma, as suggested by DE '584, in the process of Yuge '091 because the use of the inductive plasma would avoid contaminating the molten silicon".

However, Yuge '091 nowhere makes reference to a need for avoiding further contamination of the molten silicon. Indeed, the specification of Yuge '091 states that the use of

the plasma jet configuration, as disclosed in that reference, for purification "prevents the entrance of impurities into silicon from the plasma torch" (column 3, lines 55-57). Thus, a person skilled in the art, looking at Yuge '091, would not be motivated to go to the DE '584 reference, since Yuge '091 discloses that the arc plasma configuration already "prevents the entrance of impurities into silicon from the plasma torch".

Thus, there is no proper nexus for Examiner's suggested combination of Yuge '091 and DE '584; there is no recitation within the four corners of Yuge '091 which suggests going to the DE'584 reference. Applicant respectfully submits that, based on those references, such a connection would not be obvious.

Additionally, even if Examiner's suggested combination of references is made, notwithstanding the lack of a proper nexus, the claimed invention is still not made out. Claim 1 of the present invention recites the following important features:

- using a cold inductive crucible; and
- creating, by means of the inductive crucible, a turbulent stirring of the silicon melt.

The use of a cold inductive crucible has the following advantages, as described in the specification at page 5, lines 11-24:

> First, this has the advantage of not contaminating the liquid silicon, which is maintained in a skull, that is, a solid silicon skin (not shown) coats the inside of the crucible and contains the liquid silicon. Thus, the liquid silicon does not risk being contaminated by the material constitutive of walls 11 of the actual crucible, or of an intermediary wall as in known methods.
>
> Another advantage of using a cold inductive crucible is that this enables creating a turbulent stirring in the silicon melt to further the purification. Indeed, in the absence of any stirring of the silicon melt, the diffusion times of the impurities that must migrate from the inside of the melted mass to the liquid-plasma interface to be combined, then vaporized, are incompatible with a method economically viable from an industrial point of view.

Applicant also describes within the specification numerous important advantages of creating a turbulent stirring of the silicon melt, as indicated by the arrow directions in Figure 1. Such advantages include (1) the rapid bringing up of the fiuid of the lower part of the crucible to the free reactive surface, thereby enabling the combination and vaporization of impurities (page 7, lines 17-19); (2) driving solid particles, resulting from the chemical reaction of impurities with the plasma, towards wall 11 of crucible 1 (page 7, lines 24-29); (3) inverting the turbulent stirring motions, during the third "doping" phase, to improve the inclusion of hydrogen atoms in the silicon (page 10, lines 22-26); and (4) also utilizing such inversion during the initial starting phase, to improve the mixing of the silicon powders and chips to be melted down (page 12, lines 9-14).

Yuge '091 does not refer to the use of a cold inductive crucible or a turbulent stirring by means of such a crucible. That patent shows a hot crucible lined with silica (see column 2, lines 19-24). Additionally, the stirring as provided by Yuge '091 depends only on the plasma jet.

Similarly, DE '584 refers neither to a cold inductive crucible, nor to a turbulent stirring made by means of that crucible. Thus, the above mentioned important features cannot possibly be found in the combination of Yuge '091 and DE '584. Consequently, Examiner's suggested combination of references, even if made in the absence of a proper basis, still does not make the invention recited in claim 1, and such combination cannot render obvious the recitations of claim 1. That claim is therefore patentable in a 35 U.S.C. § 103 sense over Examiner's suggested combination of references.

Claim 9-10 are also rejected under 35 U.S.C. § 103(a) as being unpatentable over Yuge '091 in view of DE '584 and Hiratake et al. (4,048,436). Examiner asserts that "Yuge '091 also discloses a bottom opening 13 (note Figure 4). The silica 1a in the bottom opening 13 is kept

cooled and solidified, and it permits the electric current to flow to the water cooled electrode. This is considered the same as the claimed electromagnetic valve".

However, the electromagnetic valve of the present invention uses a configuration having a coil 51, surrounding the output aperture and imbricated in the low portion of the crucible with coil 12 of the actual crucible. In the absence of a current in coil 51, the crucible material at that height is warm, and thus conductive, but solid. When a current is applied to coil 51, a melting down of the crucible material occurs, thus opening the valve by melting of the solid silicon plug (page 11, lines 17-35). As an alternative embodiment, a small inductive plasma torch placed under the crucible emptying aperture may be used (page 12, lines 1-5).

The present invention aims at providing a refining method that can be implemented from beginning to end in a same refining installation. The opening and closing of the electromagnetic valve allows the entry into the fourth phase of the refining method, where the refined and doped silicon is cast in the form of ingots adapted to being sawn to obtain solar cells.

Yuge '091 does not refer to the use of a valve for melting a solid silicon plug, in order to permit the casting of the silicon into ingots. Indeed, the bottom opening 13 of Yuge '091 exists only to allow a voltage for plasma generation to be applied across the molten silicon and the plasma torch. It is not disclosed as a valve, at all. Thus, Applicant respectfully traverses Examiner's assertion that the arrangement shown in the Yuge '091 is the same as the electromagnetic valve claimed in the present invention.

Applicant also submits that Yuge '091, DE '584 and Hiratake '436 cannot be combined to make out the removable magnetic yoke element of claim 9, as asserted by Examiner. Neither Yuge '091 nor DE '584 refer to such an element. Hiratake '436 discloses a magnetic field

generating means to generate a magnetic field interacting with a plasma jet, to deflect the plasma jet.

However, the removable magnetic yoke of the present invention, as recited in amended claim 9, has the purpose of "inverting a stirring direction of the silicon load", as supported by the detailed description at page 10, lines 22-36 and page 11, lines 1-3. This inversion of the turbulent stirring direction furthers the inclusion of hydrogen atoms in the melt, during the third "doping" phase. This configuration is very different from the configuration shown in Hiratake '436, which merely deflects the plasma jet for the melting of metals.

Thus, Yuge '091 lacks any recitation which suggests going to either DE '584 or Hiratake '436. Therefore, there is no proper basis for Examiner's suggested combination of these references. Even if the references could be combinable as suggested by Examiner, despite the lack of a proper basis, they still do not make out the present invention recited in claims 9-10. As stated above, those claims include an electromagnetic valve and/or a removable magnetic yoke arranged for implementing the various phases of the refining method. Consequently, claims 9-10 are patentable in a 35 U.S.C. § 103 sense over Examiner's suggested combination of references.

For all of the above stated reasons, claims 1 and 9-10 patentably distinguish over any combination of the cited references. Claims 2-4 and 7-8 ultimately depend from and include all of the subject matter of claim 1, which has been shown to be allowable. Accordingly, claims 2-4 and 7-8 are also allowable over the cited references.

Additionally, Examiner has asserted in the Office Action that claims 5-6 would be allowable if rewritten in independent form. Accordingly, Applicant has cancelled claims 5-6 and rewritten them in independent form as new claims 11-12, which include all of the limitations of the previous base claims. Thus, new claims 11-12 are now also in allowable form.

CONCLUSION

Having fully addressed the Examiner's rejections and objections regarding all of the claims, Applicant submits that the reasons for the Examiner's rejections and objections have been overcome. Applicant respectfully requests that the amendments be entered and a Notice of Allowance be issued.

If the Examiner believes the prosecution of this application would be advanced by a telephone call, the Examiner is invited to contact Applicant's attorney at the telephone indicated below.

No fees are believed necessary for filing this Amendment and Response. However, if one is necessary, the Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment, to Duane Morris, LLP deposit account no. **50-2061**.

Respectfully submitted,

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VERSION WITH MARKINGS TO CLEARLY SHOW CHANGES MADE

The following version of amended claim 9 indicates an addition in underlined, bold type:

9. (TWICE AMENDED) A silicon refining installation comprising:

a cold inductive crucible (1) adapted to receiving the silicon;

an inductive plasma torch (2) directed towards the free surface of the silicon load contained in the crucible; and

a removable magnetic yoke (3) between the plasma torch (2) and the crucible (1) **for inverting a stirring direction of the silicon load**, the yoke being ring-shaped to enable the passing of the plasma flame (f).